EARTH SCIENCE INVENTORY AND EVALUATION OF THE VIOLET HILL CHANNEL–BOYNE VALLEY AREA OF NATURAL AND SCIENTIFIC INTEREST AND BOYNE VALLEY PROVINCIAL PARK

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AN EARTH SCIENCE INVENTORY AND EVALUATION OF THE VIOLET HILL CHANNEL–BOYNE VALLEY AREA OF NATURAL AND SCIENTIFIC INTEREST AND BOYNE VALLEY PROVINCIAL PARK

P.S.G. KOR

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ONTARIO HERITAGE FOUNDATION
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ONTARIO MINISTRY OF NATURAL RESOURCES
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PREFACE

The Violet Hill Channel–Boyne Valley Area of Natural and Scientific Interest (ANSI) was identified as a provincially significant earth science site during a theme study of the Niagara Escarpment (Cowell and Woerns 1976) and subsequently as part of the Ontario Ministry of Natural Resources' (MNR) Huronia District Land Use Guidelines (1983). It was previously known as Primrose–Boyne Valley earth science ANSI and is here renamed to describe more accurately its primary geological feature. The present detailed analysis of the geological and geomorphological elements in the ANSI was completed during the summer of 1990. The ANSI overlaps most of Boyne Valley Provincial Park, thus that portion of the park not in the ANSI was also surveyed and included in this report.

This inventory of the Violet Hill Channel–Boyne Valley ANSI and Boyne Valley Provincial Park was completed under the auspices of the Niagara Escarpment Heritage Protection and Land Stewardship Program funded and administered by the Ontario Heritage Foundation. The Ontario Ministry of Natural Resources, Central Region, provided logistical support for the field and office portions of the project.

I would like to thank D.K. Armstrong, Ontario Geological Survey, and W.M. Tovell, Royal Ontario Museum (retired) for providing useful discussions regarding the bedrock geology of the site. J. Riley, MNR Aurora accompanied the writer in the field and made useful and insightful comments regarding the geology and management of the site. M. McLean and S. Smith, MNR, Aurora, are thanked for their excellent cartographic services.

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ABSTRACT

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The upper reaches of the Boyne River valley occupies a minor re-entrant in the Niagara Escarpment, between the communities of Primrose and Violet Hill, about 7 km east-northeast of Shelburne, Ontario. The bedrock in the area is almost wholly buried by deep glacial sediments representing a complex of landform features related to Port Bruce Stadial deglaciation. The area was identified as having provincially significant earth science representation of the "type" area of the Orangeville Moraine and the Violet Hill meltwater channel, as well as good representation of a portion of the Singhampton-Gibraltar Moraine complex. Two levels of the Violet Hill spillway are represented in the area, the result of two periods of use by glacial meltwater flow. Protection of the site is recommended through its identification as an Area of Natural and Scientific Interest.

Bedrock in the study area is generally poorly exposed, consisting of small, scattered outcrops which display an incomplete composite section of Upper Ordovician through Middle Silurian units (upsection, from oldest to youngest): Queenston (not exposed in the ANSI), Whirlpool, Manitoulin, Cabot Head and Amabel Formations. This bedrock representation is locally significant. The geology reflects deposition of clastic (southeast source) and carbonate (northwest source) sediments over a rise in the Precambrian basement called the Algonquin Arch, hence the generally thin depth of the total section.

The western portions of the earth science Area of Natural and Scientific Interest overlaps with the eastern portion of Boyne Valley Provincial (Natural Environment) Park, and should be managed within the park as a Nature Reserve zone. The rest of the site falls within other crown holdings or under the stewardship of private landowners. It is recommended that the landform features of the area be preserved through contact with the landowners and seeking their co-operation in preventing destructive land uses.

CHAPTER 1. REGIONAL CONTEXT

1.1 Introduction

The Violet Hill Channel-Boyne Valley earth science Area of Natural and Scientific Interest (ANSI) and Boyne Valley Provincial Park are located on the Boyne River where it cuts through deep glacial deposits over the edge of a minor re-entrant in the Niagara Escarpment (Figure 1). Boyne Valley Provincial Park overlaps the western portion of the ANSI, and is included in this study. The combined ANSI/Provincial Park area will be referred to in the report as the "study area".

The study area incorporates the "type" area of the Orangeville Moraine and the Violet Hill spillway, and a portion of the Singhampton-Gibraltar Moraine complex. In conjunction with a number of other nearby sites, notably Mono Cliffs Provincial Park, the Violet Hill Channel-Boyne Valley ANSI was identified as providing provincially significant representation of these features (Cowell and Woerns 1976). Representation is also made of several bedrock units of the Niagara Escarpment in an area of the escarpment where bedrock exposure below the Amabel caprock is rare.

The Violet Hill Channel-Boyne Valley ANSI is located about 7 km east-northeast of Shelburne, in Mulmur Township, at 44°07'N Latitude and 80°06'W Longitude (NTS 41 A/1, centred on UTM 715845). The ANSI covers an area of about 1326 ha, whereas the park incorporates about 435 ha, and combine to cover roughly 1443 ha, noting that much of these two properties overlap. Access is from Highway 89, between the communities of Primrose and Violet Hill, and from numerous minor roads north of the highway. The site is boxed in by 1st Line W.H.S. (west), 5 and 8 Sideroads (north), and 3rd Line E.H.S. (east). The Bruce Trail passes through the middle of the ANSI in a north-south direction.

This inventory of Violet Hill Channel-Boyne Valley ANSI and Boyne Valley Provincial Park involved 3 days of pre-field preparations, 6.5 days of field work and 10 days of report writeup. The pre-field preparations consisted of data accumulation, including all pertinent maps, airphotos (1:10 000 scale), geological reports, and discussions with government geological staff. The field work consisted of driving all roads through the area, walking the Bruce Trail and its side loops, and traversing portions of the area using pace-and-compass techniques.

Vertical exposures in the glacial drift of the area are not common. Where roads cross major topographic breaks, such as in the banks of the Boyne River valley and between the two levels of the Violet Hill meltwater channel, good exposures of the glacial sediments are present. A few local gravel pits, abandoned and active, also provided good vertical exposures to a limited portion of the study area. Study of the surficial component of most of the study area was generally restricted to airphoto interpretation, published literature review, and hand-augered holes and cores.

The bedrock sections of the escarpment were measured and sampled at accessible locations in the bed and valley walls of the Boyne River. Rock outcrops were studied for lithology, contacts, sedimentary structures, and surface features.

1.2 Bedrock Geology

The bedrock underlying the study area are clastic and carbonate sediments of Paleozoic age. These rest unconformably on the Precambrian basement complex of the Canadian Shield at a depth of over 1350 m (Bezys and Johnson 1988). In southwestern Ontario, the Paleozoic sequence consists of Cambrian through Mississippian strata outcropping in concentric belts around the southwest trending Precambrian rise called the Algonquin Arch (Figure 2). The present study region consists of southern Ontario's most prominent

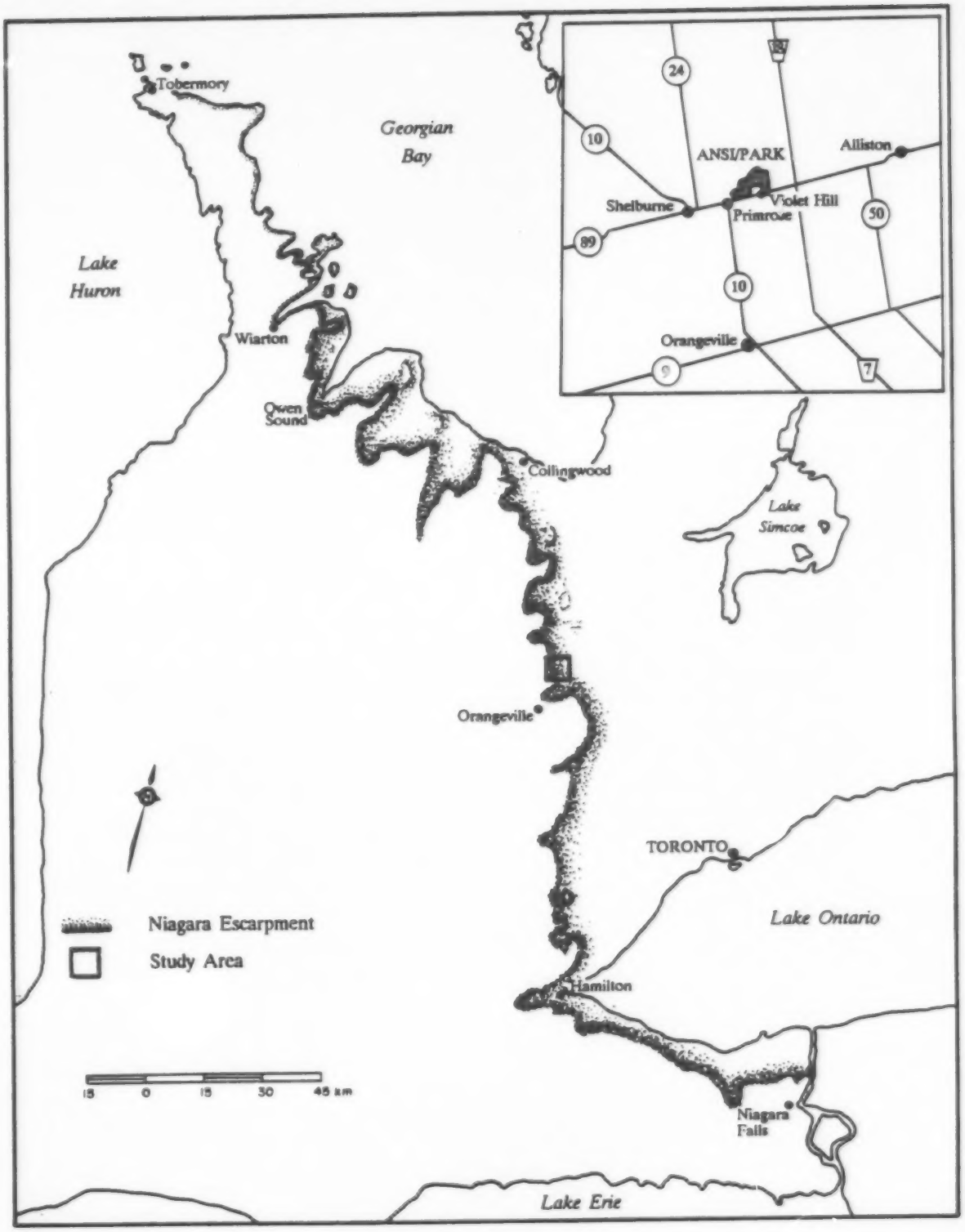


Figure 1. Location Map, Niagara Escarpment and Boyne Valley study area.

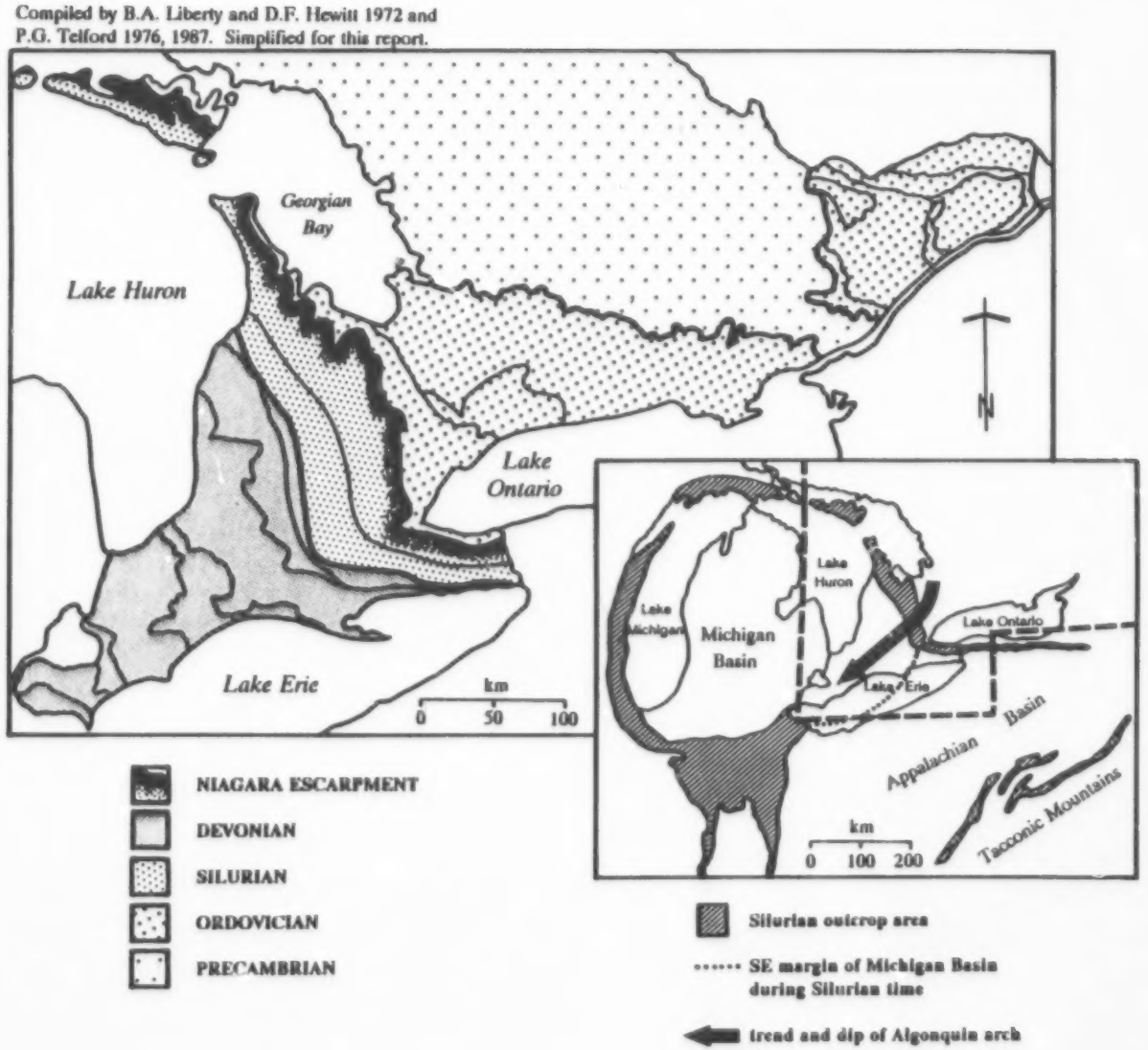


Figure 2. Structural elements of southwestern Ontario and location of the Niagara Escarpment.

topographic feature, the 600 km long Niagara Escarpment (Figure 2).

Bedrock exposures along the escarpment represent only a thin slice of the Paleozoic sequence, from the lower Queenston Formation and, rarely, the Georgian Bay Formation (Upper Ordovician), upsection through the Cataract (Lower Silurian), Clinton and Albemarle Groups (Middle Silurian). This succession was largely deposited in fluctuating, shallow marine environments between two deeper basins, the Michigan to the north and the Appalachian to the south about 450 to 415 million years ago. Sedimentation in these deeper basins was much greater than over the Algonquin Arch, which was periodically exposed above sea level. The result is that thick sediment packages are preserved in the basin areas, whereas equivalent units over the arch are thin or lacking. The relatively thin composite section exposed in the park is a reflection of sedimentary conditions over the arch.

The regional stratigraphic sequence is complicated by lateral facies changes as a result of different depositional environments reflecting differences in the distance from the material source and the depths of water in fluctuating seas. As a result, the predominantly clastic sediments typical of the Appalachian basin interfinger with mainly carbonates typical of the Michigan basin in complex onlap-offlap patterns over the Algonquin Arch (Sanford 1969; Telford and Johnson 1984).

The clastic rocks of the Appalachian basin, predominantly sandstones and shales, were created by the erosion of adjacent highlands, the Taconic Mountains (ancestral to the Appalachian Mountains) to the southeast and to a lesser degree the Canadian Shield to the north (Bezys and Johnson 1988). The significant thickening of this sedimentary package to the southeast reflects the strong influence of the Taconic Mountains and the decreasing distance from the original sources of material. In the shallow Michigan basin, carbonate sedimentation predominated, because sources for clastic sediments were minimal.

In southwestern Ontario, sedimentation during the Silurian was greatly influenced by an actively rising (or subsiding at a slower rate than adjacent basins) 'spine' in the Precambrian basement complex called the Algonquin Arch, which served to complicate the relationships between the sediments in the adjoining basins. The Paleozoic sedimentary strata were originally deposited as flat-lying units. Subsequent tectonic activities resulted in gentle, regional dips, generally to the southwest.

In Ontario, the Niagara Escarpment consists of a prominent, exposed bedrock ridge from the Niagara River west to Dundas and northward to about Milton, northwestward from Collingwood through Owen Sound, and along the Bruce Peninsula and Manitoulin Island to St. Joseph Island. The central portion between Milton and Collingwood is mostly buried or thinly veiled by glacial debris.

The escarpment is an erosional feature, created by the removal of relatively soft shales from beneath a more resistant caprock of massive carbonates. The portion of the escarpment over the Algonquin Arch, a relatively higher element of the depositional basin, is deeply cut, resulting in its greatest relief of about 287 m, near Collingwood (Hewitt 1971). Elsewhere, however, the escarpment is represented by a local topographic rise where it is masked by glacial debris. Glacial and postglacial fluvial clearing and modification of promontories, outliers and other irregularities along the escarpment enhanced and defined their size and shape, and cut through and removed debris from re-entrant and outlier valleys (Karrow 1987; Straw 1968).

The Ordovician and Silurian sediments exposed in the Orangeville area portion of the escarpment were deposited squarely over the Algonquin Arch, and were influenced by conditions in both the Appalachian and Michigan basins. Most units in the Appalachian basin thin from east to west, from Queenston to about Georgetown (Figure 3). Over the arch, they interfinger with the more uniform carbonate facies rocks deposited in the tectonically more stable Michigan basin. The upper portion of the sequence tends to be of a clastic carbonate nature due to the shallowness of the seas across the arch.

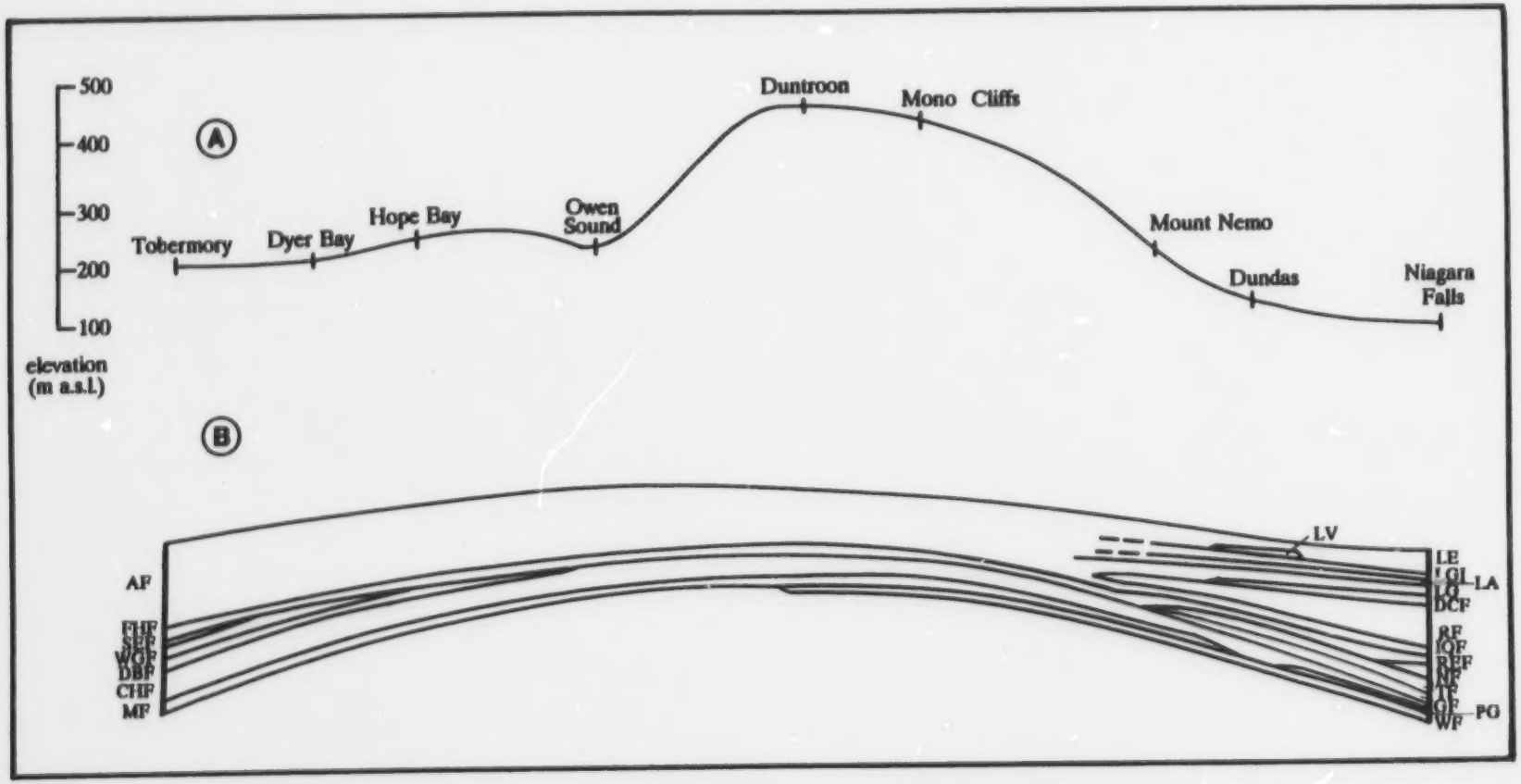


Figure 3. Stratigraphy of the Niagara Escarpment: a cross section from Tobermory to Niagara Falls; A) Simplified elevation of the brow of the escarpment; B) Idealized schematic cross section showing relationships of units (not to scale). Unit abbreviations are as follows: AF–Amabel Formation; FHF–Fossil Hill Fm; SEF–St.Edmund Fm.; WGF–Wingfield Fm; DBF–Dyer Bay Fm; CHF–Cabot Head Fm; MF–Manitoulin Fm; LE–Lockport Fm (Eramosa member); LV–Lockport Fm (Vinemount shale beds); LGI–Lockport Fm (Goat Island member); LA–Lockport Fm (Gasport member); DCF–DeCew Fm; RF–Rochester Fm; IQF–Irondequoit Fm; REF–Reynales Fm; NF–Neahga Fm; TF–Thorold Fm; GF–Grimsby Fm; PG–Power Glen Fm; WF–Whirlpool Fm. The Guelph Fm forms the top unit at or near the brow of the escarpment from Tobermory to Niagara Falls.

The shales of the Queenston Formation were deposited in an expanding delta complex over vast portions of the Late Ordovician sea, resulting in the fairly consistent occurrence of the unit throughout its exposure along the Niagara Escarpment. The onset of the Silurian saw a greater influence of structural and environmental controls on the basin topography, resulting in regionally less uniform sedimentary patterns.

The Early Silurian saw near-continuous deposition of the Cataract Group sedimentary package, reflecting a transgressive-regressive cycle of sedimentation in which normal marine sandstones gave way to deltaic redbeds and carbonates. Sedimentation over the Algonquin Arch consisted of carbonate deposits due to the shallower conditions. The close of Cataract time saw the continued but waning effects of the Taconic upland area.

During Clinton time, the seas which covered the region periodically retreated, creating interfingering packages of clastic and carbonate sediments. Interfingering thin strata of sandstones and siltstones, reflecting smaller input from adjacent upland areas, with thick carbonate strata in the eastern portions of the Appalachian basin reflect this continued but waning influence of the Taconic Mountains.

A relative shallowing of the Clinton seas provided widespread environments suitable for crinoid bank development, that is, shallow subtidal flats (Sanford 1969; Winder and Sanford 1972). The high energy crinoid bank areas at the edge of a rapidly subsiding Michigan basin separated deepwater sedimentation to the north from a shelf lagoon environment to the south, resulting in complex lateral facies relationships during Albemarle time. Subsequent widespread dolomitization further obscured the relationships between these rocks.

The rocks of the Niagara Escarpment are identified by their lithostratigraphy (physical sedimentary characteristics) and partly by their biostratigraphy (distribution of flora and fauna), which is best established on the Niagara Peninsula. These aspects of the geology of the escarpment are well documented in the classic works of Bolton (1957), Liberty (1969), Sanford (1969) and Liberty and Bolton (1971). Although their classification scheme is not unanimously supported by others in the field, the breakdown of the stratigraphy into the formations and members described herein (Figure 4) follow accepted nomenclature adopted by the Ontario Geological Survey based on the classic references cited above, and the mapping by Liberty et al. (1976).

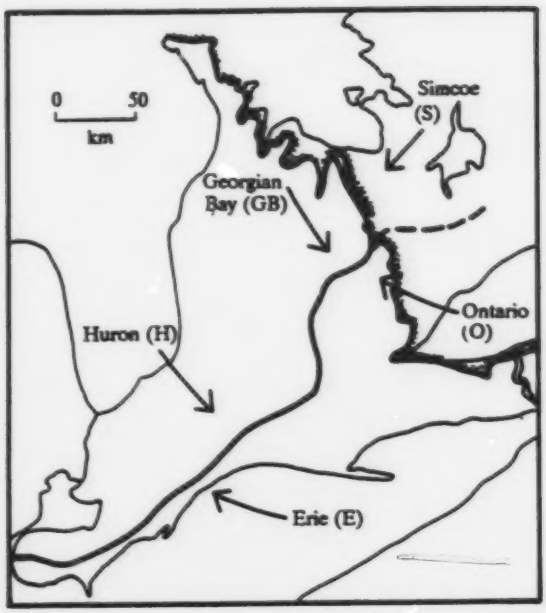
1.3 Surficial Geology

The Precambrian Algonquin Arch forms the topographic spine of southwestern Ontario, and created an upland peninsula projecting between four lake basins (Figure 2): Huron and Georgian Bay to the north, Erie to the southwest and Ontario to the southeast. Because of this topographic control, the margin of the Wisconsinan Laurentide ice sheets, originating from the northeast, were strongly lobate, with each lake basin being occupied by a major projection of the ice front. During periods of glaciation, southwestern Ontario was invaded by ice lobes expanding outward from each of these basins, creating a suture zone where they coalesced. During periods of ice retreat, a series of roughly concentric end moraines formed on the central upland, subaerially exposing an area surrounded by ice on three sides and glacial lakes to the southwest. Taylor (1913) called this emerging upland the "Ontario Island". With continued ice retreat, parts of the peninsula were flooded by waters of a succession of glacial lakes dammed between the ice and the drainage divide south of the Great Lakes. It is likely that this sequence of events was re-enacted during each successive glacial episode of the Wisconsinan.

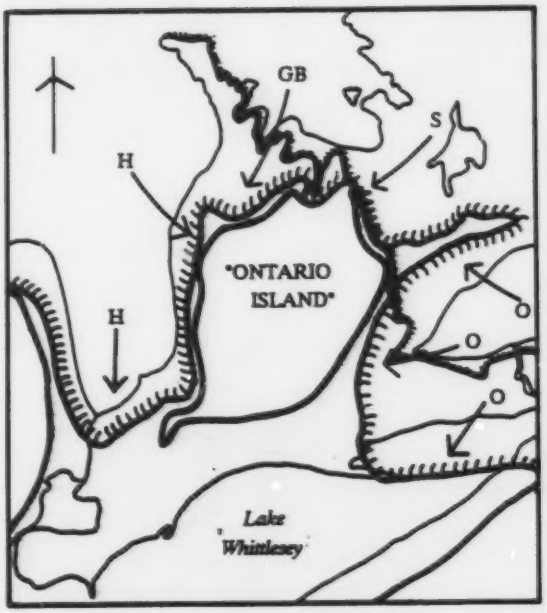
The central escarpment region encompasses features of glacial erosion and deposition which point to a complex sequence of events, the consequence of the last glacial events to mark the Late Wisconsinan in the area (Figure 5). Glacial lobes advancing from the Georgian Bay (with a sublobe from the Simcoe basin) and Ontario basins invaded the escarpment along this section, while the Huron lobe to the west served to

		Bruce Peninsula	Algonquin Arch	Niagara Peninsula
	ALBEMARLE GROUP	GUELPH Eramosa	GUELPH Eramosa	GUELPH
		AMABEL Wiarton/ Colpoy Bay Lions' Head	AMABEL unsubdivided	LOCKPORT Eramosa Vinemount Goat Island Gasport
MIDDLE SILURIAN	CLINTON GROUP	FOSSIL HILL ST. EDMUND WINGFIELD DYER BAY	FOSSIL HILL	DECEW ROCHESTER IRONDEQUOIT REYNALES NEAHGA THOROLD
LOWER SILURIAN	CATARACT GROUP	CABOT HEAD MANITOULIN	CABOT HEAD MANITOULIN WHIRLPOOL	GRIMSBY CABOT HEAD MANITOULIN WHIRLPOOL
UPPER ORDOVICIAN		QUEENSTON GEORGIAN BAY	QUEENSTON GEORGIAN BAY	QUEENSTON GEORGIAN BAY

Figure 4. Table of Formations, Niagara Escarpment (after Bolton 1957 and Winder and Sanford 1972).



a. Port Bruce maximum 14000 BP



b. Late Port Bruce Stadial 13300 BP

c. Port Huron maximum 13000 BP

d. Lake Iroquois (Ontario basin) 12000 BP

ice front

ice movement

lake

Figure 5. Regional glacial history – southwestern Ontario and central Niagara Escarpment area. (adapted after Chapman and Putman 1984).

contribute sediment and to control the movement and meltwater flow of the other lobes. During deglaciation, interlobate areas became centres of deposition and erosion due to concentrated meltwater flow. The emerging Niagara Escarpment influenced these late glacial events as ice became thin and more susceptible to the control by its topography and morphology.

The Niagara Escarpment is marked by a number of indentations or re-entrants, the origin of which are the subject of some controversy. Chapman and Putnam (1984) and Karrow (1963;1987) believe that these re-entrants in the escarpment represent preglacial drainage valleys which were enhanced by glacial erosion. Straw (1968), on the other hand, contends that the straight, overdeepened shape and consistent orientation of most of the re-entrants suggest an origin almost wholly related to glacial erosion. Shaw and Gilbert (1990), Barnett (1990) and others suggest that during the Late Wisconsinan subglacial meltwater floods, released catastrophically, were responsible for extensive landform modification throughout much of southern Ontario. The extreme erosive power of these types of flows on a variety of substrates, including bedrock, is demonstrated elsewhere (Shaw and Kvill 1984; Kor et al. 1991). The Orangeville and Hornings Mills re-entrants, and probably lesser re-entrants along the Niagara Escarpment between these two, may be in part a product of this process.

During the Late Wisconsinan, much of the Niagara Escarpment remained essentially ice-covered while complex ice movements inland cleared high ground coincident with the Algonquin Arch of glacial ice. The central portions of the Niagara Escarpment were affected by a number of advances and retreats during this time, and the topographic break served to channel ice and particularly meltwaters during several Late Wisconsinan stadials and interstadials (Straw 1968; Chapman and Putnam 1984).

The last strong ice advance to affect the region occurred during the Port Bruce Stadial, culminating about 14 000 BP (years Before Present), essentially covering southern Ontario completely (Dreimanis and Karrow 1972). Its deterioration was initiated along the interlobate area between the Huron-Georgian Bay lobes and the Erie-Ontario lobes, and is marked by the Orangeville Moraine system, a portion of which lies within the study area. During further retreat of adjacent ice lobes, the Simcoe sublobe (Georgian Bay lobe) remained vigorous and persisted in the Hockley Valley to the south (Cowan 1976). The Georgian Bay lobe and the Simcoe sublobe retreated from the Orangeville Moraine to the Singhampton Moraine, a broad ice-stagnation complex above the Niagara Escarpment to the north, and below the escarpment towards the south (as in the study area). Further retreat, or possibly retreat with a readvance, was halted at the Gibraltar Moraine position, which forms a distinct feature north and south of the Mono-Mulmur Township area, but which is not distinguishable from the Singhampton Moraine in this study area. Here the ice may have been delayed in its retreat due to a locally higher elevation and cooler temperatures resulting in a wide area of mass stagnation, or a subtle two-stage retreat (Riley 1983). The coalescence of the two ice positions through this area is also recognized by Chapman and Dell (1963) and Gwyn (1975).

During retreat of Port Bruce ice from the area, complex meltwater channel systems evolved which drained meltwaters from the ice front to glacial lakes southwest of the emerging "Ontario Island". Meltwaters from the ablating glaciers were channelled between the Orangeville Moraine and the Niagara Escarpment to the west and, first the Singhampton Moraine, then the Gibraltar Moraine to the east (Figure 6). The confined flow created flat-bottomed channels between these restrictions, exposing bedrock along the Niagara Escarpment in places, and cutting through moraine deposits elsewhere. In the study area, the Orangeville Moraine was breached by meltwaters which joined the previously established Violet Hill meltwater channel (Lavender-Violet Hill Meltwater Channel of Gwyn 1975). They flowed south from here, possibly into a water body ponded by an ice dam in the Hockley valley (Riley 1983). At least two levels of the Violet Hill meltwater channel are recognized in the study area (Figure 6).

Glacial readvance during the Port Huron Stadial, about 13 000 BP, in the central Niagara Escarpment area surmounted the escarpment to the Banks Moraine (Georgian Bay lobe) north of the study area, and re-entered the Hockley valley (Simcoe sublobe) south of the study area. Retreat of these glaciers subjected the

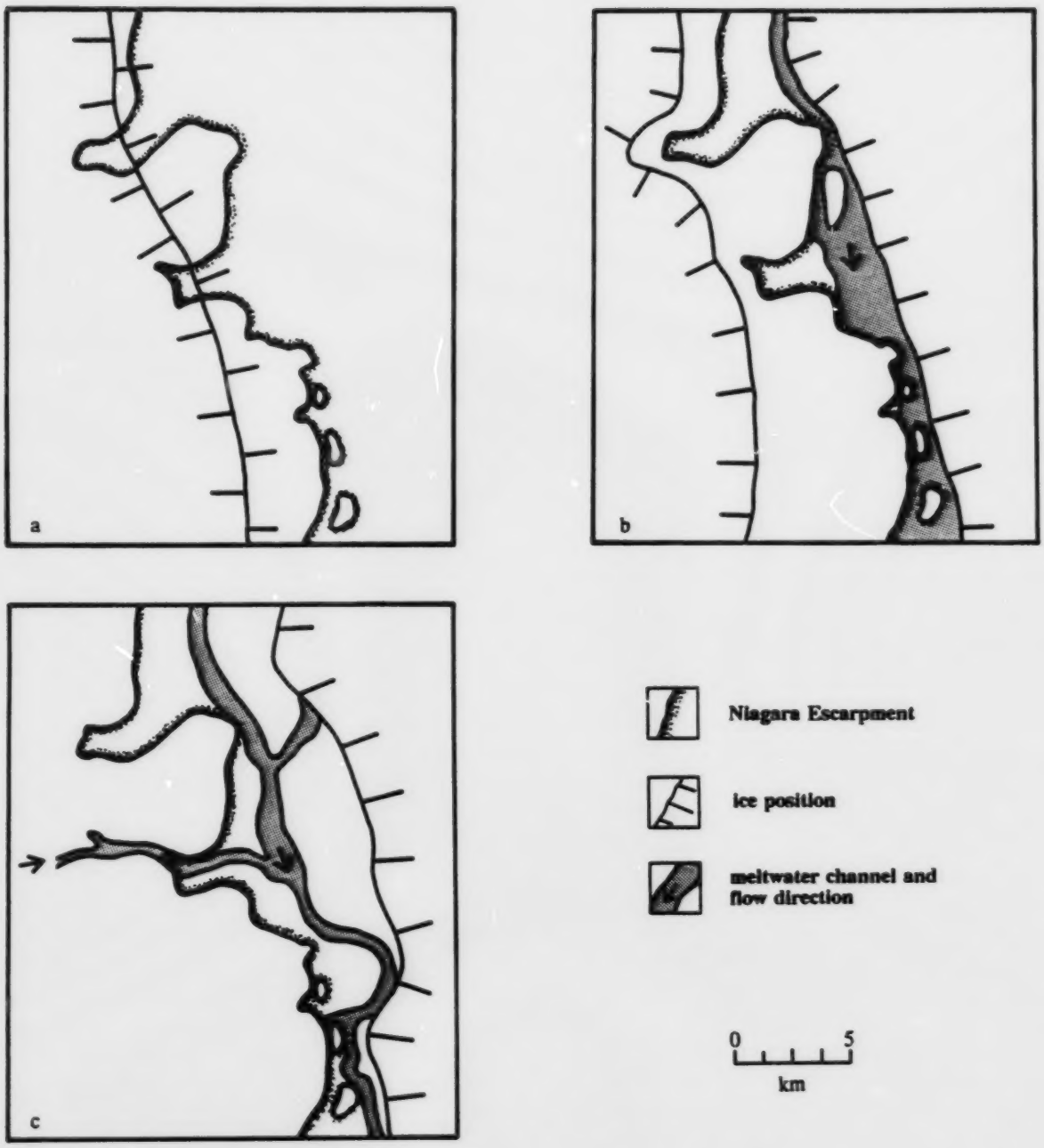


Figure 6. Main events during the deglaciation of the Violet Hill–Mono Cliffs area of the Niagara Escarpment.

a Deglaciation begins along a suture zone between the Huron lobe (west) and Georgian Bay lobe (east), initiating the Orangeville Moraine.

b Retreat to the western Orangeville Moraine position above the escarpment and the Singhampton Moraine position below the escarpment; the initial, high level of the Violet Hill meltwater channel flows adjacent to the Singhampton Moraine.

c Retreat of Huron lobe ice out of the region allows breaching of the Orangeville Moraine, and slow stagnation of the Georgian Bay lobe to the Gibraltar Moraine position produces a lower channel of the Violet Hill meltwater channel through the area.

Niagara Escarpment to subaerial erosion by runoff. In the study area, the meltwater channels were abandoned and bedrock exposed at the head of the re-entrant by downcutting of the Boyne River and its tributaries.

CHAPTER 2. GEOLOGY AND GEOMORPHOLOGY OF VIOLET HILL CHANNEL-BOYNE VALLEY ANSI AND BOYNE VALLEY PROVINCIAL PARK

2.1 General Character

The Violet Hill Channel-Boyne Valley earth science ANSI and Boyne Valley Provincial Park encompass a glacial landscape related to deglaciation of Port Bruce Stadial ice from the area. Generally, the site can be divided into three broad physiographic zones. The western portion of the site, above the buried Niagara Escarpment, consists of a rolling, hummocky landscape underlain by ice-contact sand and gravel and till of the Orangeville Moraine. A dissected single ridge trending north-south stands above the surrounding hills, marking the initial depositional area of this interlobate moraine. The hills of this area are used primarily as grazing pasture and have generally been deforested. The linear pattern of the moraines are quite evident from certain vantage points. The Orangeville Moraine in particular stands out as a high, breached ridge across Highway 89 between Primrose and Violet Hill. In the eastern portion of the ANSI, below the escarpment, a low rolling terrain also marks an area dominated by ice-contact moraine deposits. A broad stagnation zone of the Simcoe sublobe ice during a time when general retreat of the ice front occurred between the Singhampton and Gibraltar Moraines elsewhere displays a topography typically marked by small kettles and other hummocky stagnation moraine forms. Although the western margin of this zone is slightly higher than the eastern portions, differentiation between the two moraines here is not possible.

Between these two areas of moraine debris lies the Violet Hill meltwater channel, which carried meltwaters between banks consisting of ice on the east and the Niagara Escarpment on the west. The meltwater channel consists of a broad, sinuous, flat-bottomed valley with several terraces marking different water levels representing successive use through time. Two main levels indicate that initially meltwaters flowed through the area from the north, followed by a second period of flow from west of the Orangeville Moraine. This second period of flow cut a channel through the moraine and through the higher level of the first channel. The channels are for the most part cleared of forest and their character is very evident from the surrounding uplands.

Late glacial spillway erosion and postglacial streams have cut through the Orangeville Moraine to the edge of the Niagara Escarpment, and expose a number of outcrops in the narrow confluence of the Boyne River valley north of Primrose. The Boyne River flows northeastward through the study area, through a relatively shallow, wide, floodplain valley dominated by wetland vegetation. It cuts all other landscape units in the area, evidence of its Holocene to Recent history.

The few bedrock outcrops in the study area expose an incomplete section through the Niagara Escarpment typical to its central portion, from the Upper Ordovician Queenston Formation (exposed just outside the ANSI) upsection to the Middle Silurian Amabel Formation. The character of the escarpment beneath its mantle of glacial sediment is not obvious in the study area, but the exposure of some bedrock units enhance the geologic story of the site.

2.2 Site Description

In this section of the report, the bedrock formations exposed in the study area will be described and compared to their regional occurrence with reference to the Table of Formations (Figure 4). A discussion of the Quaternary sediments and landforms in the study area is also discussed. This information is presented on Map 1 (back pocket). All reference sites are located on Figure 7; UTM location coordinates are taken from Ontario Base Maps 5650 48800, 5650 48850, 5700 48800 and 5700 48850 (scale 1:10 000). The geology of the Violet Hill Channel-Boyne Valley ANSI and Boyne Valley Provincial Park is described in chronological order from oldest to youngest.

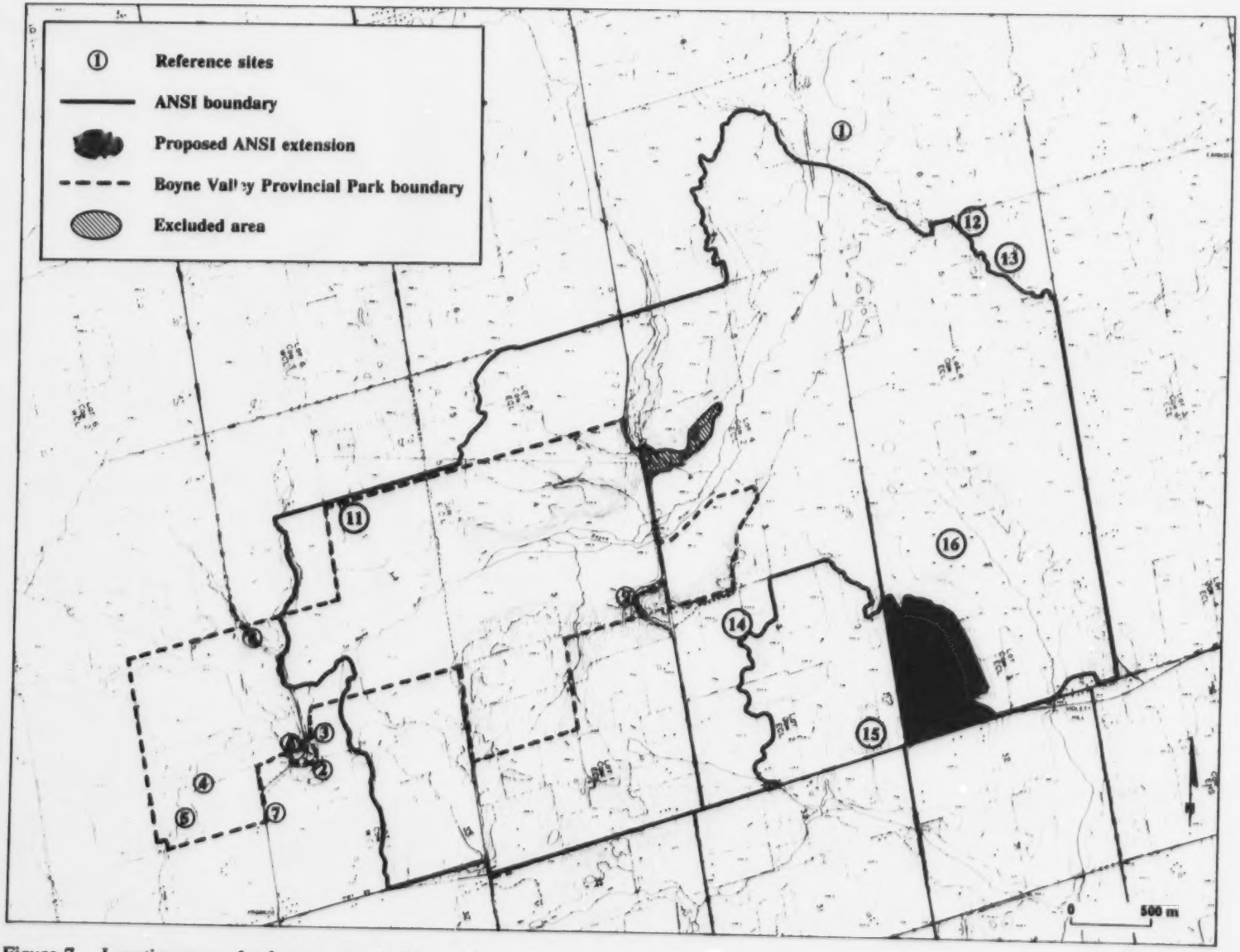


Figure 7. Location map of reference sites in Boyne Valley study area.

a) *Bedrock Geology*

Bedrock outcrop within the study area occurs at the head of a minor re-entrant in the Niagara Escarpment. An incomplete composite section is exposed primarily in the bed of the Boyne River near the restriction in its course north of Primrose, although some exposure above the valley also occurs. The river here has cut through the overlying sediments to the bedrock surface. All bedrock described occurs in Boyne Valley Provincial Park, just west of the earth science ANSI boundary. Although the Fossil Hill Formation is recognized to occur between the Cabot Head and Amabel Formation in the area (Liberty et al. 1976), it was not observed in the study area and thus is not described here.

Queenston Formation (Upper Ordovician) The Queenston Formation (also referred to as the Queenston shale) is a predominantly red shale which commonly occurs at the base of the Niagara Escarpment. Its eroded, weathered upper surface, dissected by eastward-draining streams, creates the hummocky topography of much of the terrain east of the escarpment. The lithology of the unit, consistent throughout its occurrence, is a dark red, hematitic, blocky, non-fissile calcareous and clay shale characterized by thin interbeds of grey, sublithographic, argillaceous limestone (Liberty et al. 1976). Grey-green reduction zones subparallel or transverse to the bedding are common. The unit may be over 100 m thick in the region.

Red to brown-red, clay-rich shale of the Queenston Formation is exposed in the bed and valley wall of the Boyne River just outside the ANSI boundary to the north (Site 1, UTM 722871). About 8 m of the unit is exposed in a fresh section below a cap of till and ice-contact sediment. Distinct grey-green reduction zones occur throughout the exposure. Confirmed exposures of the Queenston were not documented in the ANSI, but it likely underlies the Violet Hill meltwater channel and the Singhampton-Gibraltar Moraine complex (Liberty et al. 1976).

Whirlpool Formation (Cataract Group; Lower Silurian) The Whirlpool Formation is typically a very fine-grained, well sorted, light grey, calcareous cemented quartz sandstone (Liberty et al. 1976). Bedding is generally thin, with planar and cross bedding commonly exposed in vertical section. Thin, green, shale partings, inclusions and mud-galls are common, particularly near the top of the unit (Bolton 1964; Liberty et al. 1976). Contacts are distinct, and the unit has a variable thickness between 4 m and 9 m, thinning considerably northward to about 2 m at Collingwood.

The Whirlpool is well-exposed at the constriction in the Boyne River north of Primrose (Site 2, UTM 691831), where it is a thin-bedded, coarse-grained, granular sandstone, grey-buff in colour. The best exposures occur underneath and directly north of the road bridge at this locality. In some exposures, asymmetric ripples mark the upper surface of the beds. The thin bedding planes form a series of cross-channel riffle zones in the river bed below the bridge. Liberty et al. (1976) recorded 2.6 m of Whirlpool Formation sandstone at this site.

Manitoulin Formation (Cataract Group; Lower Silurian) Regionally the Manitoulin Formation consists of a "thick- to thin-bedded, grey, buff weathered, dense to fine-grained, argillaceous dolomitic limestone with grey shale partings throughout, and lenses of white chert" (Bolton 1957 p.14). Relict textures indicate that the beds were originally bioclastic in origin with an abundance of crinoid material (Liberty et al. 1976). Deposited in a region beyond the influence of clastic sedimentation, the Manitoulin sea was a shallow, warm, well-aerated body of water of relatively low salinity, which gave rise to a rich and varied fauna (Bolton 1957). It overlies the Whirlpool with a sharp and conformable contact. Thickness of the unit increases from about 1.3 m on the Niagara Peninsula to a roughly constant 8-10 m from Orangeville north.

In the Boyne River valley, the Manitoulin Formation is exposed in the bed and banks above the Boyne River (Site 2; Site 3, UTM 691833) as a vuggy, crinkly thin- to thick-bedded, fossiliferous, coarse

crystalline, buff-grey dolomitic limestone. Chert nodules are common to the upper portions of the unit, particularly in a small outcrop below the brow of the road below the bridge (Figure 8; Site 3). The lower contact with the Whirlpool Formation is exposed as a 3-5 cm riffle in the river bed below this location. The upper contact with the Cabot Head Formation, described by Bolton (1957) as gradational, was not observed in the study area, but an inferred maximum thickness of over 4 m for the Manitoulin Formation is indicated. Liberty et al. (1976) noted a minimum thickness of 3.8 m in the Boyne River section.

Cabot Head Formation (Cataract Group; Lower Silurian) The Cabot Head Formation is predominantly a light grey to light blue, slightly calcareous clay shale which is fissile when dry but plastic when wet (Liberty et al. 1976). Variable amounts of interbedded, grey, dense, calcareous limestone, sandstone and shale bands occur in the upper portions of the unit throughout its exposure on the escarpment (Bolton 1957). The lower contact with the Manitoulin Formation is gradational and conformable, whereas the upper contact with the Fossil Hill Formation is a sharp lithological break. Thickness varies from 15 m on the Niagara Peninsula, through a minimum of about 10 m at Hamilton, thickening northward to a maximum of over 40 m on the Bruce Peninsula (Bolton 1957).

In the study area, a single poor exposure of Cabot Head was noted on the Boyne River (Site 4, UTM 683830) below the small Amabel waterfall. Significant portions of the unit are obscured by slump, due primarily to its very soft, erodible nature and the extensive glacial ground cover. The Cabot Head consists of a very plastic, clayey, thin-bedded reddish-light grey shale with thin limestone interbeds. At least 1.5 m of the section is exposed. Contacts with adjacent units were not observed. Liberty et al. (1976) noted a thickness of 18.3 m at Hornings Mills to the north.

The Cabot Head Formation is attributed to an increase in clastic sedimentation due to renewed influence of the wearing down of the Taconic Mountains following the carbonate deposition during Manitoulin time. The shales suggest a predominantly shallow, muddy, marine environment subjected to rapid changes in sedimentation (Bolton 1957).

Amabel Formation (Albemarle Group; Middle Silurian) The Amabel Formation is a reefy dolostone which forms the caprock of the northern portions of the Niagara Escarpment. Its southernmost extent is recognized in the abandoned Kerns Road Quarry near Waterdown (Telford and Johnson 1984). Northward on the Ontario mainland, the Amabel is recognized to the top of the Bruce Peninsula. Two members are recognized north of about Georgetown: the Lion's Head and Wiarton/Colpoy Bay members (Bolton 1957). Between Georgetown and Waterdown, the Amabel grades laterally into the Lockport Formation, with which it is correlative, resulting in a mixing of lithologies which makes differentiation into members very difficult (Bolton 1957). The present study area is situated north of this transition zone. However, although textural and lithological variations allow recognition of the various members through this region, this is difficult in the study area because of the uniformity and poor exposure of the unit here (Bolton 1957; Liberty et al. 1976).

Regionally, the Amabel is described as a massive, unbedded, white to grey, fine crystalline dolostone with considerable local variations due to the nature of primary bioclastic material (Liberty et al. 1976). A minimum thickness of about 15 m is recorded in the region (Liberty et al. 1976).

In study area, the Amabel Formation is represented by a blocky, dense, medium crystalline, light buff to grey-blue dolostone. The unit is very fossiliferous, with large macrofossils, primarily crinoids and fragmental crinoidal material, commonly visible on weathered surfaces. Vuggy layers and lenses, with vugs often lined with crystals of calcite, are also common throughout the section. Bedding ranges from thick to quite thin, and exhibits a planar to slightly wavy pattern. The thin-bedded horizons are commonly weathered more deeply than the more massive, blocky horizons, resulting in preferentially weathered clefts or solution caves incised into vertical cliff exposures.

Figure 8. Photo showing the cherty bands in the Manitoulin Formation limestone (Site 3). Rock hammer (29 cm long) for scale.

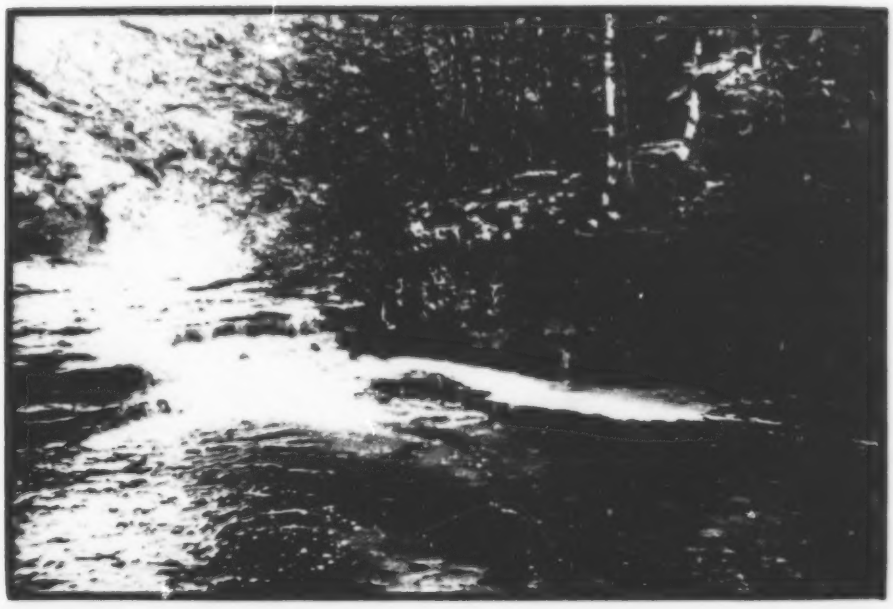


Figure 9. Photo of the small Amabel Formation waterfall, Boyne River (Site 5). Height of cliff at right is about 2 m.

The Amabel is best exposed in the west end of the study area at a small waterfall on the Boyne River (Figure 9; Site 5, UTM 683828). Minor exposures also occur near the road bridge at the valley constriction (Site 6, UTM 690832) and well above the river valley near Primrose (Site 7, UTM 688828). No more than 6 m is exposed at any one site in the study area (Site 5), but a thickness of over 20 m is inferred from the elevation of all exposures in the vicinity.

b) *Surficial Deposits*

The Violet Hill Channel-Boyne Valley ANSI and Boyne Valley Provincial Park are located in an area of confluence between the late glacial Simcoe sublobe (from the northeast) and Georgian Bay lobe (from the northwest) ice. This area of the escarpment, marked by a minor re-entrant valley through which the Boyne River now flows, marks the chaotic junction of the deposits of these ice lobes, the Orangeville Interlobate Moraine to the west and a complex of the Singhampton-Gibraltar Moraine to the east. Separating these major ice-contact bodies of sediment is the Violet Hill meltwater channel, which drained meltwaters from the north between the Niagara Escarpment and the stagnating Singhampton-Gibraltar Moraine. Ice-contact stratified drift is interbedded with glaciofluvial and minor glaciolacustrine sediments within the moraines, while sand and gravel dominate in the flat-bottomed meltwater channels (Gwyn 1975).

Till Exposures of glacial till in the study area are not common, and are generally restricted to deep sections near bedrock exposures. Two tills are recognized. The first is a red to red-brown, stony, slightly clayey, silty, coarse-grained sand in which Paleozoic clast lithologies exceed Precambrian lithologies. The red colour is the result of incorporation of Queenston shale into the till. The Precambrian clasts are generally larger and more rounded, and often exhibit fine striae and faceting. At one locality (Site 1), a stone pavement was noted to occur at the upper contact with overlying ice-contact sediment. Incorporated material of less red, more gravelly sediment is also noted, often as lenses or draped around larger clasts. This till is found below the escarpment, at or near the contact with the underlying bedrock. Excellent exposures occur in a series of roadcuts in the bank of the valley above the Boyne River (Figure 10; Site 8, UTM 687839). These exposures occur at the edge of a large knoll of till (Gwyn 1975). The till in a riverbank exposure north of the ANSI, where it overlies bedrock of the Queenston Formation, is over 3 m thick (Site 2). This red till may be a correlative of the "Ablation Till" described by Gwyn (1975) and the "Queenston-matrix till" of Burwasser (1974). It was deposited by Simcoe sublobe (Gwyn 1975).

A single outcrop of a firm, light brown, clast-poor, medium- to fine-grained sand till (Site 9, UTM 711842) may be correlative with the Tavistock Till which underlies ice-contact and outwash sediment west of the Singhampton Moraine throughout the region (Gwyn 1975). The weathered condition of the outcrop makes this assignment tenuous.

Orangeville Moraine The western portion of the study area is underlain by ice-contact sediments and till related to deposition of the Orangeville Moraine, a large interlobate deposit formed when the Georgian Bay lobe and Simcoe sublobe split during final deglaciation of the region. In the study area, the Orangeville Moraine occurs above the Niagara Escarpment. Gwyn (1975) describes the moraine as consisting of medium-grained sand with some gravel, pebbly sand and bouldery sand. The most dominant feature of the moraine in the study area is an irregular central ridge, trending roughly north-south across Highway 89 and north of the Boyne River valley. This ridge is composed of light brown, coarse- to medium-grained, stony, gravelly sand. Sand caps most of the ridge to a depth of up to several metres. Interbeds of finer material, including very thin red clay drapes and horizons containing small clay rip-ups, attest to quiet periods in the ice-contact environment. Large cobbles and small boulders form most of the oversized material, consisting predominantly of Paleozoic lithologies, reflecting its source in the basin of Georgian Bay. Rounded to subrounded, often striated and faceted, Precambrian (granitic) lithologies also occur but form only a minor component. Till may core the moraine, as it was noted to occur at the base of some deep sections.

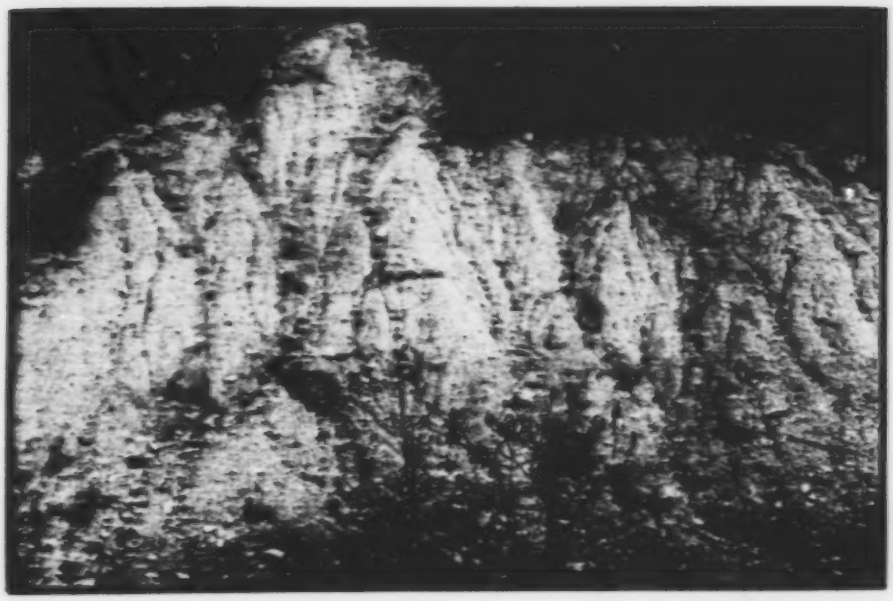


Figure 10. Photo of "ablation till" exposure (Site 8) adjacent to road through the middle of the ANSI. Adze (lower right; 90 cm long) for scale.

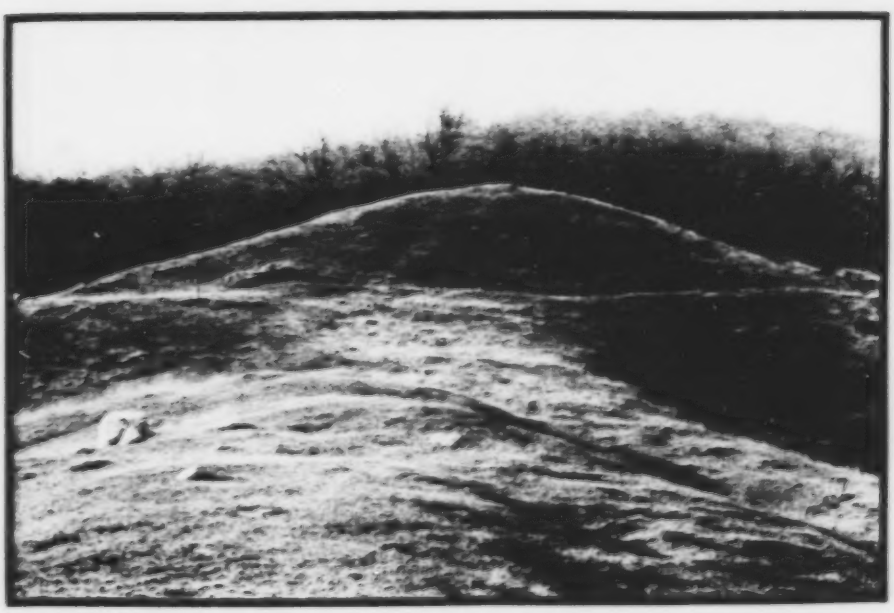


Figure 11. Photo of the highest point of the deforested Orangeville Moraine ridge (Site 11). Note the large boulders of Amabel dolostone on the surface.

The main central ridge is dissected by the Boyne River, and is marked by a number of postglacial, now-abandoned drainage rills. It is particularly visible south of the highway because it has been deforested to give way to pasture (Site 10, UTM 700821). North of the Boyne River, a side trail of the Bruce Trail crosses the summit of the Orangeville Moraine, at an elevation of greater than 500 m above sea level (asl) the highest point in the study area, providing the most spectacular views of the surrounding terrain (Figure 11; Site 11, UTM 693846). Large Paleozoic boulders litter the deforested ridge, attesting to the ice-contact deposits of which it is composed. The main ridge is surrounded on both sides by a low, hummocky topography of ice-contact material (Figure 12). Postglacial runoff has carved some of this terrain into a rilled pattern, and ice-contact features, such as kettles and kame hummocks, are not well developed.

Singhampton-Gibraltar Moraine The eastern portion of the ANSI is underlain by a hummocky terrain of ice-contact sediment related to the Singhampton-Gibraltar Moraine complex. In the region east of the study area, this moraine complex consists of a very broad highland of ice-contact stratified drift and ice stagnation features such as small kettles, indistinct ridges and fluvial channels, trending parallel to and below the Niagara Escarpment. Here the two moraines, which are recognized to the north and south as separate features (Straw 1968; Burwasser 1974; White 1975), cannot be distinguished. The complex may represent a single recessional moraine deposited during a long stillstand through Singhampton and Gibraltar time, the result of a local delay in ice retreat from this higher section of the Ontario uplands (Riley 1983). A slightly higher elevation along the western portion of the zone (Singhampton Moraine?) may signify a subtle two-part retreat of ice in the area while adjacent areas were deglaciated more vigorously (Riley 1983). The moraine complex represents the first deposits of the waning Port Bruce ice sheet of the Simcoe sublobe.

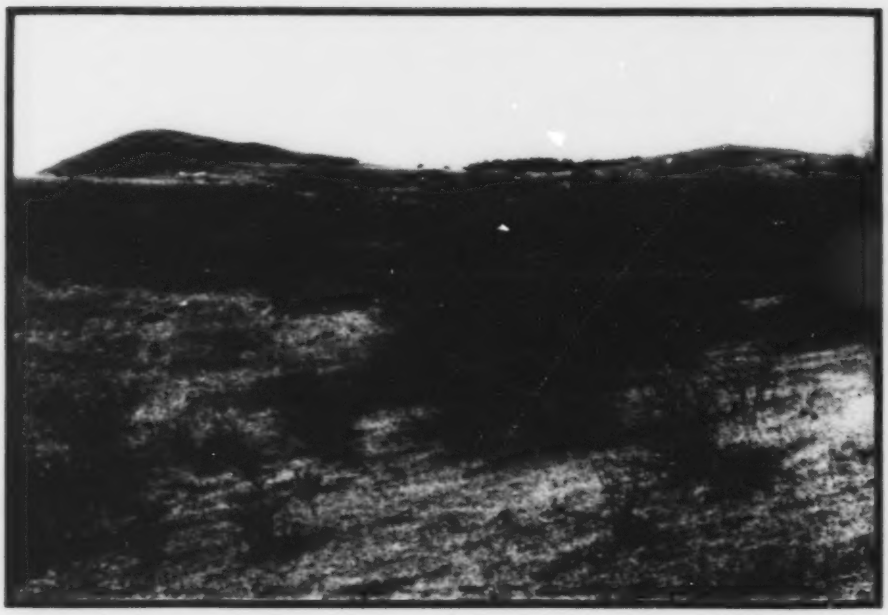


Figure 12. Photo showing low hummocky topography of the Orangeville Moraine.

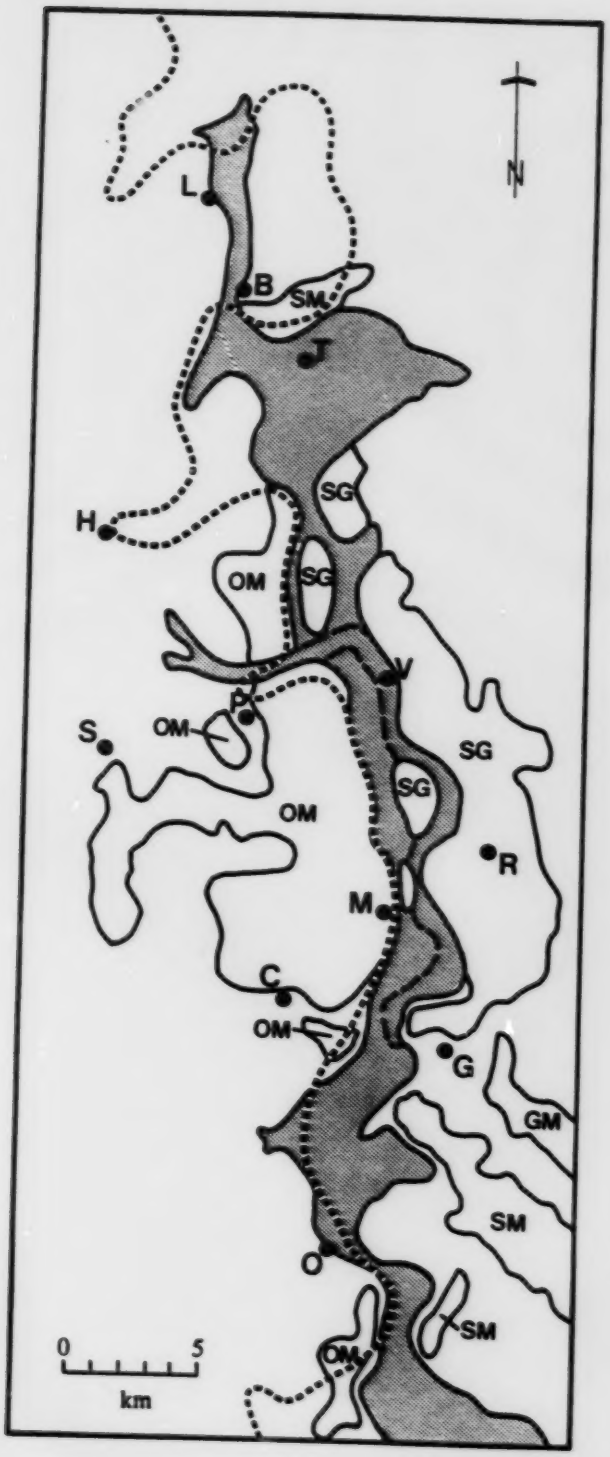
Only a small portion of the Singhampton–Gibraltar Moraine is located within the Violet Hill Channel–Boyne Valley ANSI. Here it consists of a fairly low, locally hummocky terrain punctuated by small kettles (Sites 12,13, UTM 731865,734863) and kame hills (Site 12). Constituent materials are generally stratified and fine–grained, being pebbly sands and fine gravels, with few large clasts. The clasts tend to be a mix of Precambrian and Paleozoic lithologies, attesting to the Simcoe basin origin of these deposits. The deepest sediments in the study area constitute part of this moraine, being over 98 m deep in the northeastern portion of the ANSI (Gwyn and Frazer 1975).

Violet Hill Meltwater Channel The Violet Hill meltwater channel (Lavender–Violet Hill Meltwater Channel of Gwyn 1975) originates south of Singhampton, north of the study area, and was one of the first conduits to drain meltwaters along the developing seam between the Georgian Bay lobe and the Simcoe sublobe, southward to possibly as far as glacial Lake Arkona. It was generally confined by the Niagara Escarpment (or the glacial deposits on this topographic high) to the west and the ice front, marked first by the Singhampton Moraine and then the Gibraltar Moraine, to the east (Gwyn 1975; Riley 1983). In the immediate study area, the Violet Hill meltwater channel can be traced as it emerges from a bedrock gorge near Black Bank to the north, crosses a deltaic deposit at the base of the escarpment, follows the escarpment edge through Kilgorie and Violet Hill (its "type" area due to the excellent definition and exposure here), and southward past Mono Cliffs Provincial Park and Mono Centre (Gwyn 1975) (Figure 13). The fact that preglacial and postglacial drainage in the region is to the east indicates that immediate postglacial drainage through the meltwater channel was dammed by ice occupying the Singhampton–Gibraltar Moraine system position. Substantial thicknesses of glaciofluvial sediment, from 15–60 m, are recorded in the channel (Gwyn 1975).

The bed of the northern portion of the meltwater channel in this region is situated at an elevation of about 435 m asl. In the study area it is represented by a terrace remnant (Site 14, centred on UTM 717840) in which several gravel extraction pits reveal a minimum of 8 m of planar to low–angle, gravelly channel deposits with strong southward paleoflow direction indicators (Figure 14; Site 15, UTM 725834). Minor clay drapes and lenses, and occasional lonestone debris, indicative of iceberg–rafting, suggests that ice–contact conditions still prevailed during the operation of the meltwater channel. Thick sand units often show soft sediment deformation structures, such as ball–and–pillow and faulting, suggesting rapid burial of water–saturated sediment by subsequent deposits. A general coarsening upward sequence in the vertical exposures suggest that the meltwater channel became more shallow with time, indicative of waning flow.

A lower meltwater channel level occurs incised into, and usually to the east of, the higher level. This level, at an elevation of about 407 m asl, occurs only in the Violet Hill area and southward, suggesting that it originated west of the Orangeville Moraine from where it cut through the moraine along the present Boyne River. In the ANSI, it consists of a flat–bottomed channel of generally swampy conditions trending southeast (Figure 15; Site 16, centred on UTM 730845). Distinct, incised banks mark its course from the edge of the Boyne River valley southward along the edge of the Singhampton–Gibraltar Moraine. Few fresh exposures in the deposits of this lower level occur, but generally sediments are finer grained than in the upper level terraces. Gwyn (1975) noted that the material in this lower level channel consists generally of medium–grained silty sand and pebbly sand with minor veneers of sandy pebbly gravel. The extent and location of the lower channel indicates that it represents a later phase of the Violet Hill meltwater channel, probably when the ice front retreated from the Singhampton to the Gibraltar Moraine positions.

The term 'meltwater channel' is here preferred over the misused term 'spillway'. The former refers to any conduit adjacent to or near glacial ice which carried its meltwater away from the zone of melting. 'Spillway' usually refers only to a conduit used by glacial meltwaters to drain a glacial lake. In the case of the Violet Hill meltwater channel, glacial lakes were not directly involved in the ice–contact system, although local pondings doubtlessly occurred.



Meltwater channel (upper, lower levels)

moraine

Niagara Escarpment

PLACE NAMES

L	-Lavender
B	-Black Bank
T	-Terra Nova
H	-Horning's Mills
P	-Primrose
V	-Violet Hill
S	-Shelburne
R	-Relessey
M	-Mono Centre
C	-Camilla
G	-Glen Cross
O	-Orangeville

MORAINES

OM	-Orangeville Moraine
SM	-Singhampton Moraine
SG	-Singhampton-Gibraltar Moraine
GM	-Gibraltar Moraine

Figure13.Simplified schematic showing location of main elements of the Violet Hill meltwater channel.

Figure 14. Photo of the aggregate pit wall in the upper level Violet Hill meltwater channel (Site 15). Note the interbeds of pebbly gravels and cross-bedded sands. Adze (lower left) for scale.

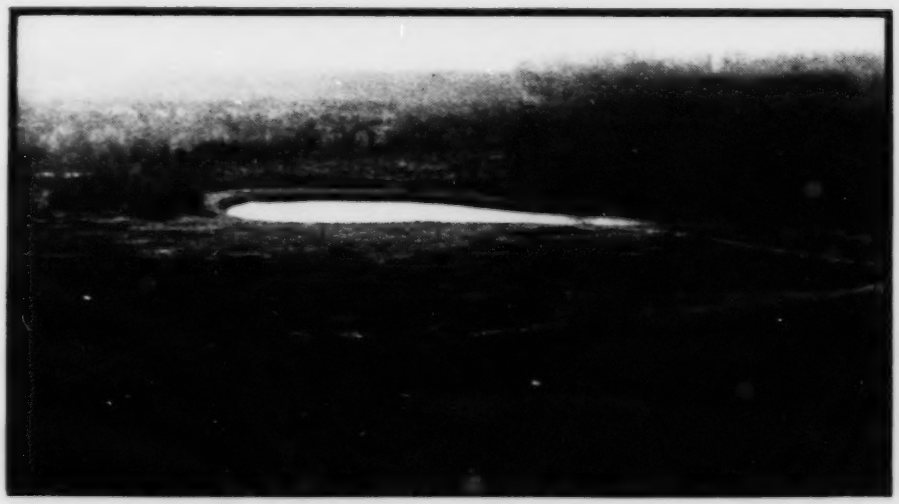


Figure 15. Photo of the lower level Violet Hill meltwater channel as viewed from the eastern moraine area. The south bank of the channel occurs just beyond the shore of the pond. In the distance are the hills of the Orangeville Moraine.

Boyne River Valley The Boyne River cut a deep, wide channel through all glacial sediments once retreating ice opened up lower terrain east of the study area. In the western portion of the study area, above the Niagara Escarpment, the river has incised the Orangeville Moraine to bedrock within the present river channel. The river flows in a broad valley floodplain consisting of a subtle braided fluvial pattern in which abandoned boulder and gravel meander scars remain. Where the river has cut through the surficial sediment to expose the bedrock ledge of the Niagara Escarpment north of Primrose, at an elevation of about 415 m asl., shallow rock valleys are created. From this area, the river follows a meandering path along a flat-bottomed, steep-banked valley at an elevation of about 400 m asl, now generally covered by wetland vegetation. The surface material in the valley, between 2-10 m thick, is consistently silty to slightly silty medium-grained sand to pebbly sand and sandy gravel. It overlies thick sequences of interbedded sand and gravel, massive to stratified lacustrine silt, or massive gravel, interpreted to represent ice-contact debris related to Simcoe sublobe ice (Gwyn 1975).

2.3 Economic Geology

Some units of the bedrock of the Niagara Escarpment have been used regionally as a source of crushable aggregate and building stone. Generally this source constitutes the lowest (Queenston shale, Whirlpool sandstone) and highest (Amabel and Lockport limestone and dolostone) units of the sequence. As bedrock in the area is deeply buried by glacial drift, with the exception of the narrow exposure in the upper river valley, it is unlikely that the bedrock of the site will be of interest to the stone and aggregate industry in the foreseeable future. The extreme western portion of the study area, where drift thickness is recorded as less than about 8 m, is considered to have significant potential for crushed aggregate (Staff of the Engineering and Terrain Geology Section 1980).

The surficial sediment within and adjacent to the study area may constitute a quality aggregate source due to its great thickness and volume. The Staff of the Engineering and Terrain Geology Section (1980) indicated that although most of the study area is underlain by considerable thicknesses of ice-contact and glaciofluvial (outwash) sand and gravel, the quality of these deposits are largely unknown at present. They rank the deposits within the study area as containing significant resource (aggregate) potential. Two active pit operations, located adjacent to the south-central portion of the ANSI, and a number of unlicensed borrow pits in the area, attest to this potential.

The Boyne River valley through the study area and its surrounding uplands lie within the area covered by the Niagara Escarpment Plan and are subject to its zoning restrictions. The core area of the lowland valley is zoned as an "Escarpment Natural Area", with a surrounding buffer zoned as an "Escarpment Protection Area". The meltwater channel and eastern moraine complex lie largely outside the escarpment planning area.

CHAPTER 3. PLANNING CONSIDERATIONS

3.1 Significant Features

The complex glacial landscape formed at the junction of two glacial lobes at the edge of the Niagara Escarpment adjacent to the present Boyne River valley was identified as an earth science ANSI due to the excellent development of the glacial features and their representation in their "type" area (Cowell and Woerns 1976). In particular, the Orangeville Moraine exhibits a topography typical to an interlobate feature, including a complex, incised central ridge with a broad apron of lower rolling hummocky ice-contact sediments. These are well exposed in the cleared fields of the rural landscape in this area, though woodlots remain on many upland sites. Representation of the Orangeville Moraine here is **provincially significant.**

A small but representative portion of the western edge of the Singhampton-Gibraltar Moraine complex is included in the ANSI. The low-relief, hummocky topography typical to this broad linear zone of ice-stagnation debris is well exposed in the generally cleared rural landscape here as well. Although representation of the moraine here is not complete, its inclusion in the ANSI is considered to be **provincially significant.** Its inclusion in the ANSI here is also significant in defining the eastern edge (west bank) of the south-flowing Violet Hill meltwater channel.

The Violet Hill meltwater channel cuts through the study area between the two moraines, below the buried brow of the Niagara Escarpment. It is significant in carrying some of the first meltwaters from the retreating Port Bruce ice, and helped define the emerging "Ontario Island". At least two periods of flow are indicated by two distinct flat-bottomed channel segments in the ANSI, defined by adjacent banks of glaciofluvial sediment. The ANSI defines the meltwater channel in its "type" area, thus is considered to be **provincially significant.** The feature is essentially undisturbed within the ANSI boundary (aggregate extraction pits occur in the feature outside the boundaries) except for surface cultivation which serves to enhance the visibility of the channel segments.

The bedrock component of the study area, not well exposed and incomplete, is considered to be locally significant. It adds little to representation of the bedrock units along this portion of the Niagara Escarpment. Its chief significance in the study area is its topographic expression beneath the mantle of drift, that of a minor re-entrant in the escarpment. This re-entrant influenced glacial ice flow and deposition and postglacial meltwater flow.

Although it is sometimes difficult to visualize large landscape features, such as moraine complexes and the meltwater channel separating them, on a per site basis, their overall significance can be interpreted through a system of trails and information boards throughout the ANSI and the park, and through an interpretive plan for Boyne Valley Provincial Park.

3.2 Recommendations

a) *Boundaries*

The earth science ANSI boundary at Violet Hill Channel-Boyne Valley, defined in the 1987 Earth Science Checksheet, incorporates a varied landscape of glacial and postglacial sediments deposited at the edge of the Niagara Escarpment. The ANSI designation provides adequate protection to the geological elements described in this report. The western portion of the ANSI lies within Boyne Valley Provincial (Natural Environment) Park (Figure 16). For the purposes of management it is recommended that the portion of the ANSI within the park be zoned and managed as a Nature Reserve.

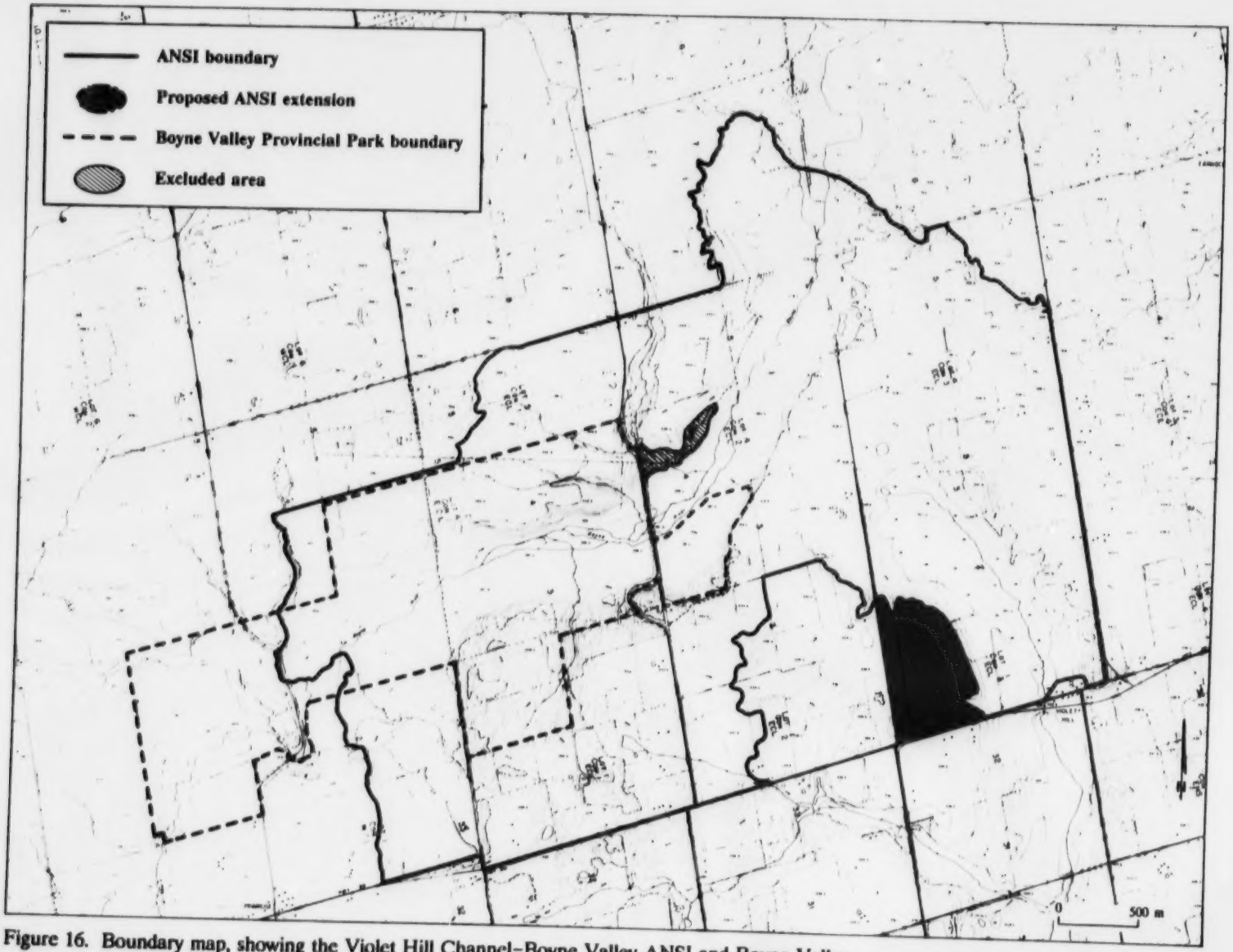


Figure 16. Boundary map, showing the Violet Hill Channel–Boyne Valley ANSI and Boyne Valley Provincial Park.

The upper level of the Violet Hill meltwater channel is not well defined in the ANSI and would be better represented by a slight boundary expansion to include an area above the terrace which marks the lower level. It is recommended that the area east of 2nd Line E.H.S. and north of Highway 89, centred on UTM 729838, covering an area of approximately 38 ha, be included in the ANSI boundary.

b) *Land Uses*

The major land uses within the study area at present are low-impact activities, primarily farming, hiking and nature viewing. Natural forest environments occur in the valley of the Boyne River and its tributaries, and on some upland slopes within the study area. The area surrounding the ANSI and the park is farmed extensively, and housing developments are becoming a common feature of the urban landscape in the area. These presently have minimal impact on the geological components of the ANSI described in the present report.

Sand and gravel pits are presently extracting the sediments of the meltwater channel south of the ANSI. The recommended boundary extension serves primarily to limit these operations such that a greater portion of the upper level terrace of the meltwater channel is left intact.

The private landowners within the ANSI boundaries should be encouraged to participate in the management and protection of "their" ANSI in conjunction with the management by MNR staff of Boyne Valley Provincial Park. Should park facilities be planned in future development of the park area, these should be directed to those areas within the park not overlapping with the earth science ANSI boundary. The best location for such facilities in this case is probably the sharp ridge in the convolution of the Boyne River north of Primrose (UTM 686838), or above the valley in the fields north of Primrose (UTM 686829).

c) *Other Environmental Considerations*

The western portion of the study area, roughly coincident with the lowland valley of the Boyne River, is identified as a provincially significant life science site (Cuddy et al. 1976). The life science ANSI boundary lies almost entirely within the earth science ANSI boundary, thereby enhancing the natural values of both components of the area.

3.3 Conclusions

The Violet Hill Channel-Boyne Valley ANSI/Boyne Valley Provincial Park area is a provincially significant geological site because of the representation of a complex glacial landscape formed during the Port Bruce Stadial. The geological values of the study area are summarized as follows:

1) Excellent representation of the Violet Hill meltwater channel; the feature here is well developed and exposed in its "type" area;

2) Excellent representation of a portion of the Orangeville Moraine and its associated features, near the "type" area;

3) Representation of a small portion of the Singhampton-Gibraltar Moraine complex;

4) Good example of Gwyn's (1975) "ablation till";

5) Poor representation of the bedrock component typical to the central portion of the Niagara Escarpment, including (upsection) the Whirlpool, Manitoulin, Cabot Head and Amabel Formations; and

6) A recommended boundary extension in the southeastern portion of the ANSI will enhance representation of the Violet Hill meltwater channel.

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AIRPHOTOS

year	roll	line	numbers
1978	134	4407	271-275
1978	134	4408	222-229
1978	134	4409	176-181
1978	134	4410	131-134

NIAGARA ESCARPMENT INVENTORY PROJECT - EARTH SCIENCE CHECKSHEET

NAME	OBM MAP NUMBER	NTS MAP NUMBER	UTM REFERENCE
Violet Hill Channel - Boyne Valley ANSI	5650 48800 5650 48850 5700 48800 5700 48850	41 A/1	715845

COUNTY: Dufferin

TOWNSHIP: Mulmur

LAT.	LONG.	AREA	ALTITUDE (MIN/MAX)
44° 07'	80° 06'	1326 ha	374m 505m

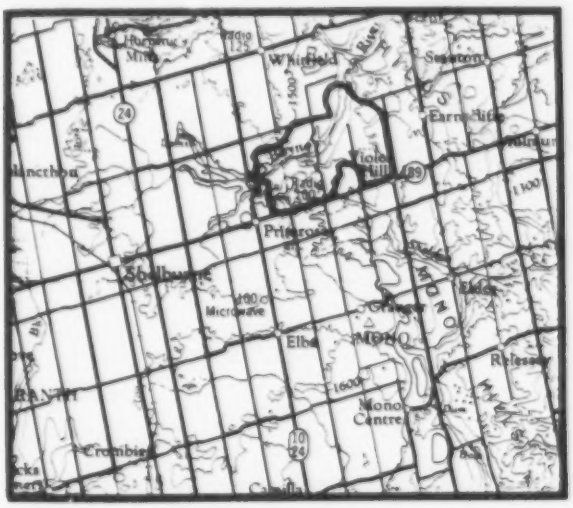
OWNERSHIP: Public/Private

MNR REGION & DISTRICT	CONSERVATION AUTHORITY
Central/Huronia	

AERIAL PHOTOGRAPHS - BASEMAPS

YEAR	ROLL	FLIGHT LINE	NUMBERS
1978	134	4407	271-275
		4408	222-229
		4409	176-181
		4410	131-134

1:250,000 NTS MAP SHOWING AREA BOUNDARIES



EARTH SCIENCE FEATURES

The Violet Hill Channel-Boyne Valley ANSI is located in an area of confluence between the late glacial Simcoe sublobe (from the northeast) and Georgian Bay Lobe (from the northwest) ice. This area of the escarpment, marked by a minor re-entrant valley through which the Boyne River now flows, marks the chaotic junction of the deposits of these ice lobes, the Orangeville Interlobate Moraine to the west and a complex of the Singhampton-Gibraltar Moraine to the east. Separating these major ice-contact bodies of sediment is the Violet Hill meltwater channel, which drained meltwaters from the north between the Niagara Escarpment and the stagnating Singhampton-Gibraltar Moraine position. Two levels of the meltwater channel, representing two periods of use, are represented in the area. Ice-contact stratified drift is interbedded with glaciofluvial and minor glaciolacustrine sediments within the moraines, while sand and gravel dominate the flat-bottomed meltwater channels.

Minor bedrock exposure in the re-entrant valley occurs where the Boyne River has cut through the thick glacial sediment cover. The ANSI overlaps with Boyne Valley Provincial Park. The ANSI overlaps with Boyne Valley Provincial Park.

SIGNIFICANCE AND SENSITIVITY

The area is identified as having provincially significant earth science representation of the "type" area of the Orangeville Moraine and the Violet Hill meltwater channel, as well as good representation of a portion of the Singhampton-Gibraltar Moraine complex. Though generally quite resistant to most existing land use, the removal of aggregate poses a danger to landform integrity and should be discouraged in the ANSI. Present rural land uses, such as grazing and farming, should be encouraged.

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DATE COMPILED	COMPILED BY
December 1991	P. Kor

Ontario Ministry of Natural Resources, Southern Region, Aurora, Ontario L4G 3G8

MAPS
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CARTES
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